DOCUMENT RESUME

ED 466 162 IR 021 233

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TITLE Improving Access Using Simulations of Community Resources.
SPONS AGENCY Rehabilitation Services Administration (ED), Washington, DC.
PUB DATE 2001-06-00
NOTE 7p.; In: ED-MEDIA 2001 World Conference on Educational Multimedia, Hypermedia & Telecommunications. Proceedings (13th, Tampere, Finland, June 25-30, 2001); see IR 021 194.
CONTRACT H128J990038-00
PUB TYPE Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Access to Information; Assistive Technology; Community Resources; Computer Oriented Programs; *Computer Simulation; *Computer Software Development; *Disabilities; Information Sources; Information Technology; Maps; *Physical Disabilities

ABSTRACT

The Community Access Through Technology Project (CATT) is developing and implementing virtual reality software that persons with disabilities can use to experience a physical location prior to visiting it in person. A virtual scenario of one physical location has been developed, implemented, and tested, and work is underway on two others. Using a computer mouse or an adaptive device, individuals can "navigate" through various environments and view short movies of processes. Detailed maps and annotations about access issues are provided for each site. Thirty-four subjects (21 males and 13 females) with physical disabilities completed the study. Disabilities of the subjects were varied an included persons with Spina Bifida, paraplegia, quadriplegia, cerebral palsy, brain injury, and multiple sclerosis. Subjects were randomly assigned to one of three groups: control group, virtual reality treatment group (VR), or the leisure education-virtual reality treatment group (LE-VR). The premise that a facilitated virtual tour prior to visitation to a new site would reduce anxiety was supported by the data. In addition, the data supported the premise that a virtual tour would increase knowledge about the facility. (Author/AEF)

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Improving Access Using Simulations of Community Resources

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ED 466 162

IR021233

Abstract: The Community Access Through Technology Project (CATT) is developing and implementing virtual reality software that persons with disabilities can use to experience a physical location prior to visiting it in person. A virtual scenario of one physical location has been developed, implemented, and tested, and work is underway on two others. Using a computer mouse or an adaptive device, individuals can "navigate" through various environments and view short movies of processes. Detailed maps and annotations about access issues are provided for each site. The premise that a facilitated virtual tour prior to visitation to a new site would reduce anxiety was supported by the data. In addition, the data supported the premise that a virtual tour would increase knowledge about the facility.

Introduction

The promise of virtual reality (VR) technologies to provide powerful and unique educational and informational experiences is well known (Heim, 1998). Unfortunately, the public has often turned away from these technologies when expectations went unfulfilled due to hyperbole on the part of the media. Despite setbacks, however, use of VR is growing and will soon become commonplace, according to some researchers (Von Schweber, 1998). Currently, researchers at Metropolitan State College of Denver are using VR to assist individuals with physical disabilities become more self-sufficient. Specifically, VR software is being used to model various public buildings and

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other sites that individuals with disabilities may want to visit. Therapeutic recreation specialists then use the software with patients to allow them to virtually preview sites that they may later want to tour in person. This approach may build confidence in the clients and may lead to greater independence once they reenter society. By enhancing this social self-efficacy, it is anticipated that carry-over will occur into employment, independent living, family support, and economic independence.

Review of Literature

One in seven Americans, or 35 million individuals, have a disability severe enough to interfere with life's day-to-day activities (Scherer, 1996, p. 4). Of those individuals, 305,000 reside in the City of Denver, Colorado (United States Census Report, 1990). Providing avenues for these individuals to maximize their full inclusion and integration into varied aspects of community life is essential.

Statistics support the need for inclusive, transitional services. Figures indicate that over 1,500 youth with disabilities are preparing for transition into the community from the public schools (Denver Public Schools, 1994). Furthermore, clinical agencies (e.g., rehabilitation hospitals) in the Denver Metropolitan area have over 1,600 new patients each year (Denver Parks and Recreation Special Needs, 1996), with over 200 referred to community-based services annually (Denver Parks and Recreation Transition to Recreational Activities in the Community, 1994, 1995).

Virtual reality literature discusses many benefits for patients. Rothbaum, Hodges and Kooper (1997) reduced the fear of heights in patients after virtual reality exposure therapy. Wilson, Foremen and Stanton (1997) demonstrated that spatial information acquired by physically disabled children from exploration of a virtual environment will transfer to a real-world equivalent environment; Ring (1998) has suggested that patients with disabilities can be trained with virtual reality to judge architectural barriers and tackle environmental obstacles. The researcher advocates the use of virtual reality as a significant assistive technology in the future (Ring, 1998). This clear support of technology deserves the opportunity for development, not just to provide individuals with simulated experiences but to use the technology for the integration of people with disabilities into society.

Methods

Subjects

Thirty-six subjects with physical disabilities were recruited through advertisements in local newspapers, and through direct mailing to local hospitals, community housing facilities, non-profit agencies, and disability advocacy groups. All subjects were initially screened to ensure that they met minimum guidelines for participation in the study, which included being age 18 or older, no prior participation at the 20th Street Recreation Center, no cognitive deficits, and having a physical disability that impaired mobility. Subjects were randomly assigned to one of three groups: control group, virtual reality treatment group (VR), or the leisure education-virtual reality

treatment group (LE-VR). Thirty-four subjects, 21 males and 13 females, with a mean age of 47.5 years (range = 23 to 84 years) completed the study. Disabilities of the subjects were varied and included persons with Spina Bifida, paraplegia, quadriplegia, cerebral palsy, brain injury, and multiple sclerosis.

Instruments

Self-Evaluation Questionnaire

The State-Trait Anxiety Inventory (STAI) (Spielberger, 1983) was one measure used to assess anxiety. The state anxiety scale (Form Y), used to measure a temporary condition of apprehension, tension, nervousness and worry, was completed by subjects. The scale is comprised of 20 statements with a range of 4 possible responses to each. The STAI has been used more extensively in psychological research than any other anxiety inventory (Buros, 1978). Data indicate that the state scale of the STAI has reliability coefficients above .90 for samples of working adults, students, and military recruits, with a median coefficient of .93. Additionally, it is reported that alpha reliability coefficients are typically higher for the state-anxiety scale when given under conditions of psychological stress (Spielberger, 1983, p. 14). Extensive research into the validity of the STAI has been conducted, and it is reported that the state-anxiety scale repeatedly has demonstrated sensitivity to environmental stress. Furthermore, the STAI has been shown to have excellent psychometric properties for the assessment of anxiety in elderly persons (Spielberger, 1983, p. 20).

Visual Analog Scale (VAS)

Each subject was asked to perform a self-evaluation of anxiety at baseline and at the conclusion of their site tour. An 11-point Visual Analog Scale (VAS) (McCall, Fischer, Warden, Kopcha, Lloyd, Young and Schomaker, 1998; Vogelsang, 1988) was used. Lower scores (0-3) indicated greater comfort with the environment; middle scores (4-7) reflected moderate comfort, while higher scores (8-10) indicated severe discomfort.

Heart Rate (HR) Measurement

In order to assess physiological changes as a result of anxiety, heart rate data were collected. Heart rate data were recorded every 5 seconds and stored using a Polar Accurex Plus Heart Rate Monitor (Polar Electro Oy, Kempele, Finland). All HR data were downloaded from the HR monitor's wrist receiver to a computer via a Polar Interface Plus (Polar Electro Oy, Kempele, Finland). Each subject had his or her HR measured to establish (A) a baseline and again while touring (B) the 20th Street Recreation Center.

(A). Baseline

Heart rates were measured during an hour of "normal" daily activity while at home or in another "comfortable" environment chosen by the subject. An average HR was determined for this time period.

(B). 20th Street Recreation Center

While touring the 20th Street Recreation Center, the heart rate monitor was used to ascertain physiological changes due to environmental anxiety. Subjects completed 11 assigned tasks while touring the Center. The subject pressed an event marker on the HR wrist receiver while also identifying the task by talking into a voice-activated cassette

recorder. This enabled the identification of a specific heart rate during a specific time interval.

Recreation Information Questionnaire (RIQ)

A 12-item Recreation Information Questionnaire (RIQ) was developed to ascertain the subject's knowledge of recreation-related information, frequency of recreation center use, and community independence. Composite scores were calculated by adding correct responses for each statement.

Technology Questionnaire (TQ)

A technology questionnaire assessed the subject's technology sophistication, such as their ability to utilize voice mail, e-mail, FAX machines, word processing, and search for information on the World Wide Web. This instrument was adapted from the Flashlight Project (Ehrmann and Zúñiga, 1997). Flashlight™ is comprised of various assessment tools useful in helping to answer questions about technology, and it has been subjected to content validity testing.

Demographic Data

Each subject was requested to provide demographic information that included their age, sex, ethnicity, disability, current employment status, living arrangement, health status, use of assistive devices, and methods of transportation.

Experimental Design

The 20th Street Recreation Center, a large multi-purpose facility operated by the City of Denver, Colorado, Department of Parks and Recreation, was created into a virtual environment that included photo-realistic panoramas of the facility, digital video of recreation equipment use, access annotations, and interactive maps of the facility. Potential subjects were initially screened to ensure meeting eligibility requirements and then were randomly assigned to either a control group (n=13), treatment group one that received virtual reality only (VR) (n=10) or treatment group two that received leisure education using the virtual reality scenario (LE-VR) (n=11). All subjects were pre-tested in their home or "comfortable" environment to determine baseline anxiety levels (i.e., Self-Evaluation Questionnaire, HR, and VAS), recreation knowledge (i.e., RIQ), technology sophistication (i.e., TQ), and demographic data.

Control group subjects independently toured the 20th Street Recreation Center, completing 11 assigned tasks such as signing up for a recreation center pass, locating specific exercise equipment, and viewing the swimming pool. During the tour, subject's HR was recorded and tour data noted on voice-activated tape recorders. At the conclusion of the tour, subjects were met by project staff to complete their post-evaluation questionnaires and paperwork for receiving a stipend for participation.

Similarly, subjects in the VR only treatment group and LE-VR treatment group followed an identical protocol for their 20th Street Recreation Center visit. However, the subjects assigned to the VR treatment group had an opportunity to view and "navigate" through the Center virtually prior to their actual on-site tour. Each VR only subject, either coming to a computer lab of the CATT project or by having staff bring a laptop computer into the subject's home, virtually toured the facility, navigating through the various rooms, examining equipment, and viewing the digital video clips. Staff had been

instructed to assist subjects in using the computer only and not to provide explanation or information about the facilities.

Subjects in the leisure education-virtual reality (LE-VR) group also utilized the 20th Street Recreation Center virtual environment but had this computer tour facilitated by a certified therapeutic recreation specialist (CTRS). A leisure education program, created through a modified program planning process (Peterson & Stumbo, 2000), was used by the recreation therapist to assist LE-VR subjects in using the community facility. Content of the program included information about transportation, facility accessibility information, fees/costs for participation, equipment and adaptations available, and services provided through the Special Needs Program of Denver Parks and Recreation Department.

Results

The premise that a facilitated virtual reality tour administered prior to visiting the 20th Street Recreation Center would reduce anxiety, was supported by a difference in means from the STAI ($p=.104$).

The premise that a virtual tour prior to visitation to a new site would provide detailed, necessary information about that facility also was supported by the data. Analysis of data from the RIQ showed significant differences between both the VR-Only and the LE-VR treatment groups and the control group ($p=.003$).

The premise that use of a virtual tour alone prior to visitation of a new site would alleviate anxiety in subjects with mobility impairments, was not supported by the data. Subjects in the VR only group were administered three instruments, then provided the treatment of the virtual reality experience, and then measured again at the 20th Street Recreation Center location. Data indicates an increased level of discomfort, anxiety, and heart rate. While mean HR site data was lower for this group of subjects than for similar subjects in the control group, the range was much greater.

The Technology Questionnaire was administered to all subjects prior to site visitation. It assessed the technology sophistication of the subjects, including their ability to use voice mail, e-mail, FAX machines, word processing, and the World Wide Web. In order to determine whether an individual's knowledge of technology was a factor in levels of anxiety, a technology score was formed by adding together individual responses to technology questions. A significant negative correlation was found between technology composite scores and pretest anxiety scores. This would indicate that those who score higher in technology knowledge tended to score lower on self-reported anxiety in the pretest.

Future Research

Future research may attempt to recruit subjects with mobility impairments from rehabilitation hospitals that are involved in active rehabilitation. This population may include persons with more recent disabilities, and these persons may exhibit greater anxiety when utilizing community-based facilities.

Additionally, more analysis needs to be performed on the HR data since it is suspected that physical exertion at the site may result in increased heart rate in addition to anxiety. A second physiological measure, such as salivary cortisol, may be useful in measuring neuroendocrine responses to anxiety in a natural environment (Bandelow, Wedekind, Hüther, Broocks, Hajak, Pilz and Rüther, 1997).

Finally, the production technology used for the virtual reality experience was only marginally immersive since it relied on Hypertext Markup Language (HTML) and Virtual Reality Modeling Language (VRML). Newer, more immersive and interactive technologies may be more effective in reducing anxiety. The use of these technologies needs to be explored in field-based settings. In addition, the virtual reality experiences need to be more "user friendly" and easier to use for persons without extensive technological experience.

Acknowledgements: Partial funding for this project has been provided through the U.S. Department of Education, Rehabilitation Services Administration, Award H128J990038-00

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